

Complementary Nucleon Pick-up and Stripping Experiments and New Data on Nuclear Subshells

I.N.Boboshin, and V.V.Varlamov

*Skobeltsyn Institute of Nuclear Physics of Lomonosov Moscow State University,
Leninskie Gory, 119992 Moscow, Russia*

Abstract. Due to significant systematical errors of the experimental nuclear spectroscopy data obtained by different methods one is often forced to deal with a very discrepant data. To remove the systematical errors and increase data accuracy and reliability, new data processing technologies were developed. One can obtain also new information have not (could not) been obtained before. It is shown that energies of the first 2^+ levels in Zr isotopes can be explained in the framework of the shell-model approach. A separation of $2d_{5/2}$ subshell in ^{96}Zr (like $1f_{7/2}$ subshell in ^{48}Ca) is found, so the neutron number $N = 56$ becomes like a magic number for $Z = 40$. To explain a similarity in decay properties of ^{48}Ca and ^{96}Zr an additional interaction between closed structures consisting of 20 and 28 nucleons is proposed. Irregularities of the ground state spin values in K isotopes are explained by the inversion of the proton $1d_{3/2}$ and $2s_{1/2}$ orbitals.

INTRODUCTION

The methods of the extracting of the physical information from data of any experiment are based usually on using of relationships of a definite degree of generalization. If it is possible to connect data of two or more experiments using more general relations than those used for data extracting from experiments it means that one has a group of complementary experiments. Connecting each other of the complementary experimental data via more general relations can help to overcome information limitation of typical data obtained in ordinary way: it means a removing a systematical deviations caused by assumed model dependence from data analyzed jointly.

The nucleon pick-up and stripping reactions experiments on the same initial nucleus present an example of the complementary pair concerns. The values of the spectroscopic factors can be obtained from these experiments by taking into account, as a rule, the DWBA normalization procedure and definite kind of the nuclear potential. As a result, absolute values of the spectroscopic values can differ by factor 2 and more. Besides, ignorance of some j values increases the systematical uncertainty significantly. The only exception is experiments with polarized particles. However, if spin and parity of the initial nucleus are equal to 0^+ the total transferred angular momentum is equal to that of a level feeding in the final nucleus.

PUTTING NUCLEON PICK-UP AND STRIPPING REACTION DATA IN ACCORDANCE TO EACH OTHER

The main idea of the method¹⁾ is to correct the experimental data so that the following constraints:

$$S_{nlj}^+ + S_{nlj}^- = 2j + 1 \quad (1)$$

should fill out 3 single-particle orbitals closest to Fermi energy, for which data are presented with a maximum of completeness²⁾. Moreover,

$$S_{nlj}^+ + S_{nlj}^- \leq 2j + 1 \quad (2)$$

for the rest, and

$$\left| \sum_{nlj} S_{nlj}^- - \sum_{nlj} S_{nlj}^+ - N \right| \rightarrow 0 \quad (3)$$

for all. Here S_{nlj}^\mp are sums of the individual spectroscopic factors $S_{nlj}^\mp(E_x)$ of levels with energies E_x . The upper signs $+$ and $-$ denote a nucleon stripping and pick-up, correspondingly. The sum in (3) is taken over valent and upper subshells in the first term and over the lower subshells in the second one. N is a nucleus total number of nucleons (protons or neutrons). The essence of (3) is that a residual interaction does not change the total number of nucleons in a nucleus. To this aim two degrees of freedom are used: (i) a new normalization condition for experimental data

is introduced ($S_{nlj}^+(E_x) \rightarrow n^+ S_{nlj}^+(E_x)$, $S_{nlj}^-(E_x) \rightarrow n^- S_{nlj}^-(E_x)$); (ii) all known information about a spin of the final states is taken into account, and moreover, all possibilities are investigated for states with unknown spins.

As a result, intervals for factors n^+ and n^- as well as for j values are determined. More reliable values of spectroscopic factors allow one to avoid a discrepancy between various experimental data, both pick-up data and stripping data.

Nucleon occupation probabilities of single-particle orbitals

$$N_{nlj} = \frac{[S_{nlj}^- + (2j + 1 - S_{nlj}^+)]}{2(2j + 1)} \quad (4)$$

and single-particle energies

$$-E_{nlj} = (1 - N_{nlj})[B(A + 1) - e_{nlj}^+] + N_{nlj}[B(A) + e_{nlj}^-] \quad (5)$$

are determined by using the improved spectroscopic factors. In (5) $B(A)$, $B(A + 1)$ are separation energies of a corresponding nucleon in a target nucleus and in a nucleus with one added nucleon; e_{nlj}^+ , e_{nlj}^- are centroids of the spectroscopic factor distributions.

Databases ENSDF^{3,4)} and NSR⁵⁾ were used as a source of the pick-up, stripping, and spin value data.

EVIDENCE OF THE MAGITY OF ^{96}Zr

Table 1 presents the energies of the first 2^+ states in $^{90,92,94,96}\text{Zr}$ isotopes. There are clear maxima at $N = 50$ and $N = 56$. The $N = 50$ maximum has an ordinary explanation, because $N = 50$ is the well-known magic number. However, the $N = 56$ maximum demands a special explanation.

TABLE 1. Rounded energies of the first 2^+ states of even-even nuclei of Zr.				
Nucleus	^{90}Zr	^{92}Zr	^{94}Zr	^{96}Zr
Number of neutrons N	50	52	54	56
$E(2^+,1)$, keV	2187	935	919	1751

Neutron single-particle energies obtained via the method described above are displayed in Fig. 1. Increasing in N leads to a lowering of the $2d_{5/2}$ subshell from the shell $N = 51 - 82$ so that in ^{96}Zr the subshell becomes well separated from it. Since in ^{96}Zr the neutron subshell $2d_{5/2}$ is closed, $N = 56$ becomes somewhat like a magic number (analogous picture of a separation of the subshell $1f_{7/2}$ in Ca isotopes was found out earlier⁶⁾, the neutron number $N = 28$ was suggested to consider (Fig.2) as a magic one). Correspondingly, two maxima of the energies of the first 2^+ states at the neutron numbers $N = 20$ and $N = 28$ one can observe in Ca isotopes (see Table 2).

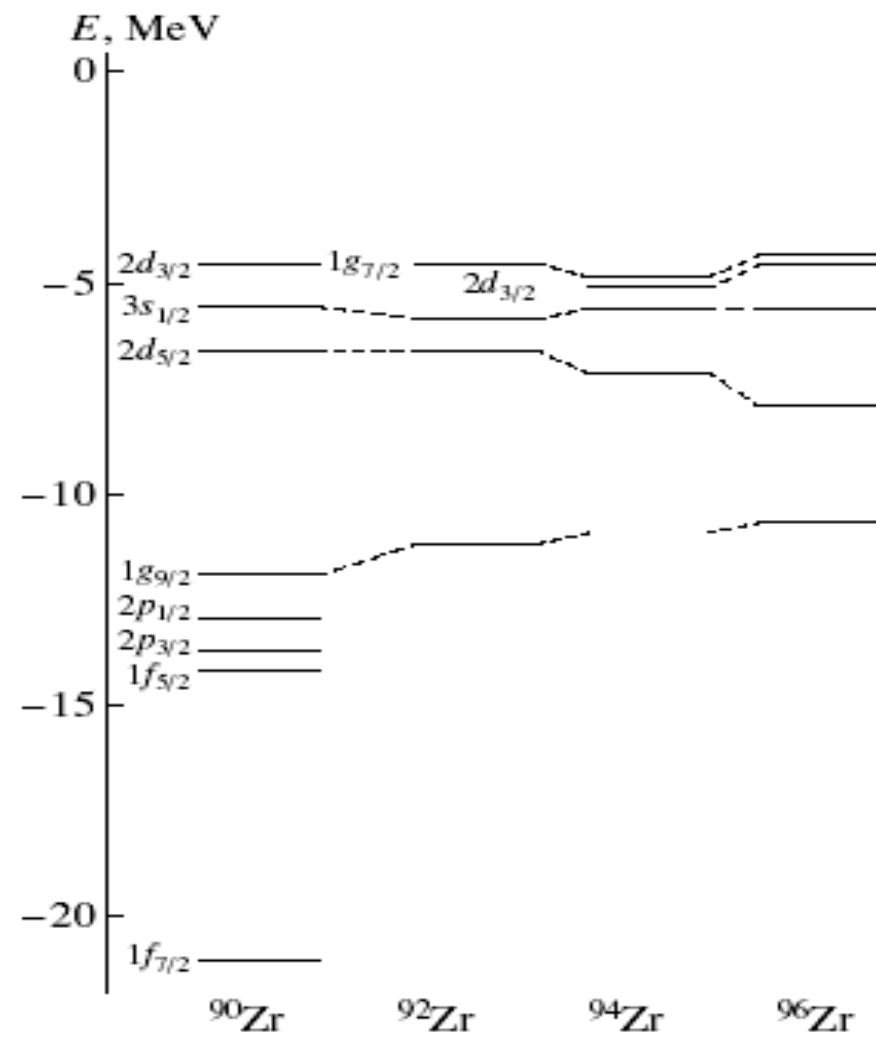


FIGURE 1. Positions of neutron subshells in $^{90,92,94,96}\text{Zr}$ isotopes.

TABLE 2. Rounded energies $E(2^+,1)$ of the first 2^+ states of even-even nuclei of Ca.					
Nucl	^{40}Ca	^{42}Ca	^{44}Ca	^{46}Ca	^{48}Ca
N	20	22	24	26	28
E, keV	3905	1525	1157	1346	3832

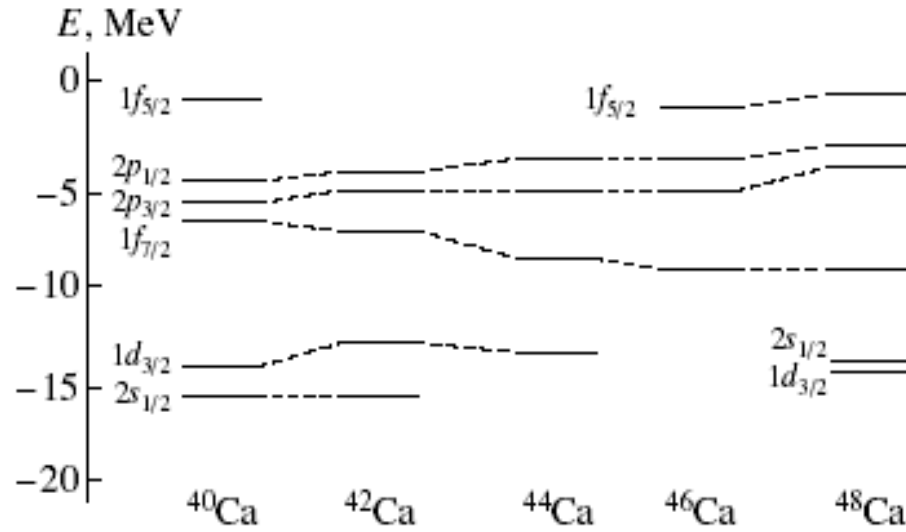


FIGURE 2. Positions of neutron subshells in $^{40,42,44,46,48}\text{Ca}$ isotopes.

Table 3 presents the results of investigations of proton subshells in Zr isotopes. Whereas the occupation probabilities in $^{90,92,94}\text{Zr}$ are close to 0.1 in the $1g_{9/2}$ orbital (thus corresponding to one proton in this orbital), probability of the proton $1g_{9/2}$ orbital appears to be exactly zero in ^{96}Zr . This follows from distributions of single-proton spectroscopic factors over final states in Y isotopes: while in $^{89,91,93}\text{Y}$ one can observe one-proton transfers with $l = 4, j = 9/2$ and spectroscopic factors $S^-(E_x) = 0.9 - 1.3$ to levels in the excitation energy range 0.5 - 0.9 MeV, similar transfers to the states of ^{95}Y nucleus are not observed at all. It means that a rearrangement of nuclear structure takes place in ^{96}Zr so that this nucleus becomes stiffer and, probably, its shape becomes closer to a

spherical one. This feature is typical for a magic nucleus, thus we conclude that $N = 56$ is a magic number for a nucleus with $Z = 40$.

TABLE 3. Nucleon occupation probabilities N_{nlj} and single-particle energies $-E_{nlj}$ (MeV) of proton orbits in nuclei $^{90,92,94,96}\text{Zr}$.					
Nlj	N_{nlj}-E_{nlj}	^{90}Zr	^{92}Zr	^{94}Zr	^{96}Zr
1g _{9/2}	N_{nlj}	0.06(5)	0.08(5)	0.09(5)	0.00(0)
	$-E_{nlj}$	5.41(54)	4.98(142)	6.74(80)	7.48(750)
2p _{1/2}	N_{nlj}	0.58(5)	0.49(3)	0.75(5)	0.81(5)
	$-E_{nlj}$	6.97(70)	7.66(77)	9.37(94)	10.59(106)
1f _{5/2}	N_{nlj}	1.00(2)	1.00(2)	1.00(2)	0.94(5)
	$-E_{nlj}$	10.37(110)	10.93(110)	11.49(115)	12.17(122)
2p _{3/2}	N_{nlj}	-	-	0.87(5)	-
	$-E_{nlj}$	-	-	11.11(112)	-

It is worthwhile to point out that the number $N = 56$ is not a magic one combining with other Z values, i.e. for Mo, Ru isotopes, etc. This fact forces us to pay attention to a relation between numbers 40 and 56. Let us note that 56 is equal to 2×28 , and 40 is equal to 2×20 and then we follow along the way of an analogy between ^{96}Zr and ^{48}Ca . Indeed, the analogy goes quite far, if we consider a data on decays of these two nuclei. Both nuclei, ^{48}Ca and ^{96}Zr , decay via $2\beta^-$ mode – quite rare decay, which is less than 1% of all type decays, and $T_{1/2}(^{48}\text{Ca}) = (4.2^{+3.3}_{-1.3}) \times 10^{19}$ years⁷⁾, $T_{1/2}(^{96}\text{Zr}) = (2.1^{+0.8}_{-0.4} \text{ (stat)} \pm 0.2 \text{ (syst)}) \times 10^{19}$ years⁸⁾. This is really fantastic coincidence: one nucleus is twice as large as the other one, and both of them decay via the same rare mode. Moreover, the half-life time of the heavier is exactly one half of the lighter.

All these facts can be explained if one supposes the existence of an additional interaction between closed structures $Z = 20$ and $N = 28$ in the nuclei ^{48}Ca and ^{96}Zr . The nucleus ^{48}Ca is known as a neutron-rich nucleus although it is quite stable. Interaction between the proton $Z = 20$ and the neutron $N = 28$ closed structures can be responsible for this specific stability.

At least two heuristic schemes of a coupling between proton and neutron subsystems can be proposed in the framework of the above assumption: a compound cluster model and a “nuclear crystal” model.

The first model (see Fig.3) supposes two levels of interactions of cluster-like structures.

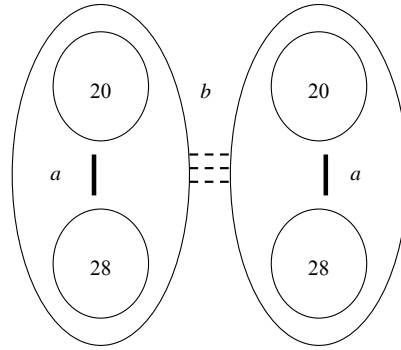


FIGURE 3. A scheme of ^{96}Zr compound cluster model.

The interaction \mathcal{A} couples $Z = 20$ and $N = 28$ structures to ^{48}Ca , and its destroying leads to $2\beta^-$ -decay with half-life 4.2×10^{19} years. The interaction \mathcal{B} couples “clusters” ^{48}Ca to the ^{96}Zr nucleus. The interaction \mathcal{B} is supposed to be stronger than the interaction \mathcal{A} , and destroying one of two \mathcal{A} -interactions leads to destruction of the whole system and to $2\beta^-$ -decay with total half-life 2.1×10^{19} years.

The second model supposes two-valent coupling between $Z = 20$ and $N = 28$ structures in ^{48}Ca (Fig.4a). ^{96}Zr nucleus is constructed from these two-valent structures like a molecule (Fig.4b). Thus, in both cases, ^{48}Ca and ^{96}Zr , one gets systems with additional stiffness that could be characterized as “nuclear crystal”.

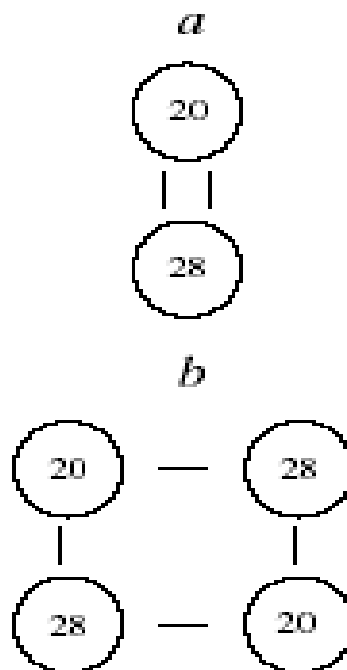
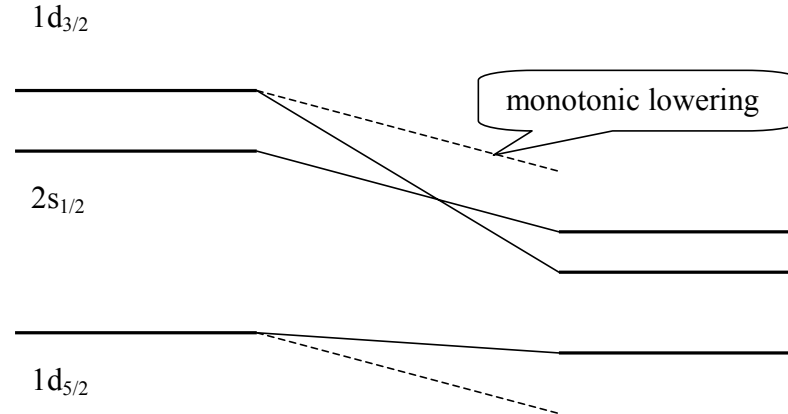


FIGURE 4. A two-valent coupling model: a - ^{48}Ca ; b - ^{96}Zr .

POSITIONS OF PROTON SUBSHELLS IN CA ISOTOPES

In Table 4 one-nucleon occupation probabilities as well as single-particle energies of proton orbitals in nuclides $^{40,42,44,46,48}\text{Ca}$ obtained from pick-up, stripping, and spin value data are presented. One can observe the inversion of the $1d_{3/2}$ and $2s_{1/2}$ subshells in ^{48}Ca isotope. This peculiarity explains irregularities in spin-parity values of the ground states K isotopes: $^{39,41,43,45}\text{K}$ the ground states are $J^\pi = 3/2^+$, whereas ^{47}K ground state is $1/2^+$. To describe the placement of proton subshells in ^{48}Ca and, in particular, the inversion of $1d_{3/2}$ - $2s_{1/2}$ subshells, it was assumed that a proton spin-orbit splitting decreases in this nucleus.



This hypothesis was tested by calculations within a dispersion optical model for $^{40,42,44,46,48}\text{Ca}^8$ and it was shown that this assumption allows one to describe the inversion adequately.

TABLE 4. Nucleon occupation probabilities N_{nlj} (upper numbers) and single-particle energies $-E_{nlj}$ (MeV) of proton orbits in nuclei $^{40,42,44,46,48}\text{Ca}$.					
	^{40}Ca	^{42}Ca	^{44}Ca	^{46}Ca	^{48}Ca
$1f_{5/2}$	-	-	-	-	0.00
	-	-	-	-	3.81(12)
$2p_{1/2}$	0.00	-	-	-	0.01 (1)
	-2.38 (24)	-	-	-	2.35 (68)
$2p_{3/2}$	0.09 (0.02)	0.02 (1)	0.05 (2)	-	0.01 (1)
	0.73 (29)	1.30 (18)	4.99 (51)	-	3.95 (53)
$1f_{7/2}$	0.06 (2)	0.08 (3)	0.13 (3)	0.02 (2)	0.02 (2)
	1.67 (22)	4.09 (45)	7.68 (78)	7.89(99)	8.62 (100)
$1d_{3/2}$	0.97 (3)	0.76 (7)	0.72 (7)	0.94 (4)	0.94 (5)
	9.52 (152)	10.03 (150)	10.81 (108)	13.53 (138)	15.96 (100)
$2s_{1/2}$	1.00	0.90 (5)	0.77 (7)	0.93 (4)	0.84 (9)
	10.94 (109)	> 11.29	11.39 (114)	13.94 (139)	14.41 (158)
$1d_{5/2}$	0.96 (2)	-	-	-	-
	14.32 (143)	-	-	-	-

CONCLUSIONS

On the base of the nuclear spectroscopy data analysis new interesting information about the single-particle structure of the Zr and Ca isotopes is obtained. The most important conclusions are the following:

- Behavior of the energies of the first 2^+ levels in Zr isotopes is explained in the framework of a shell model approach. A strong separation of the neutron $2d_{5/2}$ subshell in ^{96}Zr (like it is with the $1f_{7/2}$ subshell in ^{48}Ca) is found, so that the neutron number $N = 56$ can be considered as a magic one in a nucleus with $Z = 40$. To explain some correlations in decay properties of ^{48}Ca and ^{96}Zr an additional interaction between closed structures of 20- and 28 nucleons is proposed.
- Irregularities of the ground state spins along the K isotopic chain are explained in the framework of a shell model approach by the inversion of the $1d_{3/2}$ and $2s_{1/2}$ proton orbitals.

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Calculator for Nuclear Reaction Threshold and Energy Values
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CAJAD Charged Particle Reaction Cross Section Catalogue
Low Energy Isomer Transition Internal Conversion Probabilities

29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr		
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd
47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe		
55 Cs	56 Ba	La-Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt
79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn		
87 Fr	88 Ra	Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110
111	112	113	114	115	116	117	118		

Lanthanides

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
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Actinides

89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
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68.53	32-GE-68	11994.8 (7)	18-		1006.4 (10)	36.0 (11)	109
68.57	32-GE-68	11995.0 (7)	18-	2001WA02 , 1999HE16 1990HE1	1006.4 (10)	1.73 (5)	109
118.49	52-TE-118	10538			1002		
118.56	52-TE-118	10538		1987CL21	1002		
119.53	53-I-119	10724.9 (4)	59/2-		1002.9 (2)	100	97
119.55	53-I-119	10724.8 (4)	59/2-	1997TO03	1003.9 (2)	2.29 (9)	97
122.50	54-XE-122	10001.4 (12)	(23-,24-,25-)		1024 (1)	5.1 (10)	89
122.50	54-XE-122	10198 (3)	(25+)		1027 (1)		91
122.53	54-XE-122	10001.4 (12)	(23-,24-,25-)	1987HA03	1024 (1)	5.1 (10)	89
122.53	54-XE-122	10198 (3)	(25+)	1987HA03	1027 (1)		91
134.52	60-ND-134	11335.8 (10)	(29-)		1007.4 (2)	1.02 (4)	103
134.58	60-ND-134	11335.8 (10)	(29-)		1007.4 (2)	1.02 (4)	103
136.57	60-ND-136	10190.6 (7)	(26+)		1018.4 (2)		91
136.57	60-ND-136	10638.0 (17)	(27+)		1020		96
136.61	60-ND-136	10190.9 (7)	26+	1996PE08 , 1996PE06 , 1999PE1	1018.4 (2)		91
136.61	60-ND-136	10638.2 (19)	27(+)	1996PE08 , 1996PE06 , 1999PE1	1020		96
143.67	64-GD-143	11942.8 (23)	(65/2+)		1007 (1)		109
143.69	64-GD-143	11942.8 (23)	(65/2+)	2000LI14 , 1998SU04	1007 (1)		109
148.35	62-SM-148	10609.1 (4)	(30)		1007.9 (2)		96
148.55	62-SM-148	10609.1 (4)	(30)	1979HA19 , 1985SI16 , 1991UR0	1007.9 (2)		96
149.58	64-GD-149	10510.0 (7)	(63/2)		1008.3 (3)	100	95
149.62	64-GD-149	10509.4 (8)	(63/2+)	1991FL02 , 1995FL01 , 1998BY0	1008.3	10.9 (4)	95
150.59	66-DY-150	10327	(29-)		1021.4		
150.63	66-DY-150	10327	(29-)	1987DE23	1021.4		

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Data type (any, adopted, experimental)

any

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Mass Number ☐ Select for output

Stable ☐ Select for output

Levels (E, JPI, T1/2, etc.)

Query parameters:

Energy (keV) ☒ Select for output

"100-500", "1550,7000-10000"

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68.53	68-GE	11994.8 (7)	18+		1006.4 (10)	36.0 (11)	10988.5 (7)	16+
68.57	32-GE-68	11995.0 (7)	18+	2001WA02, 1992HE16, 1990HE16	1006.4 (10)	1.73 (5)	10988.6 (17)	16+
118.49	52-TE-118	10538			1002			
118.56	52-TE-118	10538		1987NLZY	1002			
119.53	53-I-119	10724.9 (4)	59/2-		1003.9 (2)	100		
119.55	53-I-119	10724.8 (4)	59/2-	1997TO03	1003.9 (2)	2.29 (9)		
122.50	54-XE-122	10001.4 (12)	(23-,24-,25-)		1024 (1)	5.1 (10)		
122.50	54-XE-122	10198 (3)	(25+)		1027 (1)			
122.53	54-XE-122	10001.4 (12)	(23-,24-,25-)	1987HA03	1024 (1)	5.1 (10)		
122.53	54-XE-122	10198 (3)	(25+)	1987HA03	1027 (1)			
134.52	60-ND-134	11335.8 (10)	(29-)		1007.4 (2)	1.02 (4)		
134.58	60-ND-134	11335.8 (10)	(29-)		1007.4 (2)	1.02 (4)		
136.57	60-ND-136	10190.6 (7)	(26+)		1018.4 (2)			
136.57	60-ND-136	10638.0 (17)	(27+)		1020			
136.61	60-ND-136	10190.9 (7)	26+	1996PE08, 1996PE06, 1999PE1	1018.4 (2)			
136.61	60-ND-136	10638.2 (19)	27(+)	1996PE08, 1996PE06, 1999PE1	1020			
143.67	64-GD-143	11942.8 (23)	(65/2+)		1007 (1)			
143.69	64-GD-143	11942.8 (23)	(65/2+)	2000LI14, 1998SU04	1007 (1)			
148.35	62-SM-148	10609.1 (4)	(30)		1007.9 (2)			
148.55	62-SM-148	10609.1 (4)	(30)	1979HA19, 1985SI16, 1991UR0	1007.9 (2)			
149.58	64-GD-149	10510.0 (7)	(63/2)		1008.3 (3)	100		
149.62	64-GD-149	10509.4 (8)	(63/2+)	1991FL02, 1995FL01, 1998BY0	1008.3	10.9 (4)		
150.59	66-DY-150	10327	(29-)		1021.4			
150.63	66-DY-150	10327	(29-)	1987DE23	1021.4			

Get all data.

Output table and links to ENSDF source file and appropriate NSR document.

Mozilla

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68GE (HI, XNG) 2001WA02, 1992HE16, 1990HEYS02NDS

68GE H TYP=FUL\$AUT=T. W. BURROWS\$CIT=NDS 97, 1 (2002)\$CUT=23-Sep-2002\$

68GE C The level scheme and GAMMA-ray energies and placements generally

68GE2C follow that of 1992HE16 and 1990HEYS up through the 10298-KEV stat

68GE3C For additional discussion, see 1995BH05. The reminder of the scher

68GE4C is from 2001WA02

68GE C States at 3400, 5000, and 7243 and their associated G's reported b

68GE2C 1981DE03 and 1983KIZW were not observed by 1993RAZZ, 1992HE16, or

68GE3C 2001WA02 and, therefore, have not been adopted. A state at 4460

68GE4C reported only by 1983KIZW has also not been adopted.

68GE C 2001WA02, 2000WAZU, 2002WAZU: 40CA(32S,4PG) E=134 MeV. Measured EG,

68GE2C GG, and GG(THETA) (DCO) using ^GAMMASPHERE array, consisting of 10:

68GE3C ^Ge(HP) detectors, in conjunction with ^MICROBALL, 4PI array of 98

68GE4C CsI(Tl) scintillators. Deduced super-deformed band. Band and JPI

68GE4C assignments from 2000WAZU differ in some cases, particularly for t

1 documents found (from 1 to 1 Visible).

Get All Data

<KEYNO >2001WA02

<HISTORY >A20010109

<CODEN >JOUR PRVCA 63 014301

<REFERENCE>Phys.Rev. C63, 014301 (2001)

<AUTHORS >D.Ward, C.E.Svensson, I.Ragnarsson, C.Baktash, M.A.Bentley, J.A.Cameron, M.P.Carpenter, R.M.Clark, M.Cromaz, M.A.Deleplanque, M.Devlin, R.M.Diamond, P.Fallon, S.Flibotte, A.Galindo-Uribarri, D.S.Haslip, R.V.F.Janssens, T.Lampman, G.J.Lane, I.Y.Lee, F.Lerma, A.O.Macchiavelli, S.D.Paul, D.Radford, D.Rudolph, D.G.Sarantites, B.Schaly, D.Seweryniak, F.S.Stephens, O.Thelen, K.Vetter, J.C.Waddington, J.N.Wilson, C.-H.Yu

<TITLE >Band Structure of (+68) Ge

<KEYWORDS>NUCLEAR REACTIONS (+40) Ca(+32)S,4p,E=134 MeV; measured El,g,l,g/g-, (charged particle)g-coin. (+68) Ge deduced high-spin levels, J, pi, configurations, superdeformed band, terminating bands. Gammasphere, Microball arrays. Cranked mean-field calculations.

<SELECTRS>T:40CA;A. R:(32S,4P);A. N:68GE;A. M:G-SPECTRA;A. N:68GE;B. D:HIGH-SPN;B. D:LEVEL-PROP;B. D:SUP-DEF;B.

[link to ENSDF](#)

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EVALUATED NUCLEAR STRUCTURE DATA FILE (ENSDF) Complete Nuclear Spectroscopy Database "Relational ENSDF"

Construct your query and output by sequential openings of needed fields.
One output field must be selected (not be blank) at least.

[Core information \(Nucleus, Levels, Gamma transition, Decays, Data type\)](#)

[Data type \(any, adopted, experimental\)](#)

any

[Nucleus \(Z, A\)](#)

Query parameters: Select for output

Charge Number (Element) "5,20,4-36", "Be,Zr,Fe-Zn" ☒

Mass Number

Stable any ☐

[Levels \(E, J^π, T_{1/2}, etc.\)](#)

Query parameters: Select for output

Energy (keV) 9000-10000 "100-500", "1550,7000-10000" ☒

Spin and parity 69/2+ ☐

Half-life times Y or ☐ Stable ☒

Angular momentum transfer any ☐

Spectroscopic strength

Metastable any ☐

Isospin

Adding remark any ☐

Titanium

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ENSDF Source	Nucleus	Level energy	Spin-parity	Half-life	Reference	Photon energy	Level energy (fin.)	Spin-parity (fin.)
155.36	66-DY-155	9884	(69/2+)	<= 0.8 PS		1034	885	(65/2+)
155.40	66-DY-155	9884	(69/2+)	<= 0.8 PS	1984RIZX	1034	885	(65/2+)
157.34	67-TB-157	998.6 (6)	69/2+			969.1 (4)	8415.5 (4)	65/2+
157.37	67-TB-157	984.7 (5)	69/2+		1992RA17	969.1 (4)	9015.6 (3)	65/2+
159.34	68-ER-159	9826	(69/2+)			954	8872	(65/2+)
159.36	68-ER-159	9826	(69/2+)			954	8872	(65/2+)
161.33	68-ER-161	9766	69/2+			960	8806	65/2+
161.36	68-ER-161	9766	69/2+			960	8806	65/2+
163.31	68-ER-163	9845.9 (10)	(69/2+)			998.2 (8)	8847.7 (6)	(65/2+)
163.31	68-ER-163	9909.4 (6)	(69/2+)			922.4 (4)	8986.9 (6)	(65/2+)
163.31	68-ER-163	9909.4 (6)	(69/2+)			1061.8 (3)	8847.7 (6)	(65/2+)
163.33	68-ER-163	9845.9 (10)	69/2+		1997HA23	998.2 (8)	8847.7 (6)	65/2+
163.33	68-ER-163	9909.4 (6)	69/2+		1997HA23	922.4 (4)	8986.9 (6)	65/2+
163.33	68-ER-163	9909.4 (6)	69/2+		1997HA23	1061.8 (3)	8847.7 (6)	65/2+
163.45	71-LU-163	9916.4 (6)	(69/2+)			989.2	8927.2 (6)	(65/2+)
163.47	71-LU-163	9914.7 (9)	69/2+		1992SC03	990.3 (3)	8924.4 (9)	65/2+
163.48	71-LU-163	9916.1 (9)	69/2+		2002JE05 , 1999DO34	989.2	8926.9 (8)	65/2+
165.36	70-YB-165	9923.7	(69/2+)			1058.1 (2)	8865.6	65/2+
165.38	70-YB-165	9923.7	(69/2+)		1987BE07 , 1984SC23	1058.1 (5)	8865.6	65/2+
167.32	70-YB-167	9524.6 (14)	(69/2+)			1070.5 (5)	8454.0 (13)	(65/2+)
167.34	70-YB-167	9524.3 (19)	69/2+		1996SM05 , 1995FI01 , 1985BA4	1070.5 (5)	8453.8 (18)	65/2+
167.42	72-HF-167	9839 (4)	(69/2+)			1027.3	8811 (3)	(65/2+)
167.44	72-HF-167	9838	69/2+		1999CR01 , 1999SM13	1027.3	8811	65/2+
171.38	72-HF-171	9990.9 (7)	(69/2+)			1043.3 (3)	8947.6 (7)	(65/2+)
171.41	72-HF-171	9989.7 (7)	69/2+		2000CU01 , 1997CU01	1043.3 (3)	8946.4 (6)	65/2+

Get all data

“Relational ENSDF”
query for levels with $J^\pi = 69/2^+$
and energies 9 - 10 MeV (energies of gammas and final
level energies and J^π are requested also).

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[Nucleus \(Z, A\)](#)

Query parameters:

Charge Number (Element) ☒ Select for output

Mass Number ☐

Stable ☐

[Levels \(E, J \$\pi\$, T \$_{1/2}\$, etc.\)](#)

Query parameters:

Energy (keV) ☒ Select for output

Spin and parity ☒

Half-life times ☒

Angular momentum transfer ☐

Spectroscopic strength ☐

Metastable ☐

Isospin ☒

Adding remark ☐

[Gamma transition \(Gamma ray, Final level\)](#)

[Gamma ray \(E, Int, Mult, Mix, Convers.\)](#)

Query parameters:

Energy of the γ -ray (keV) ☒ Select for output

Relative photon intensity ☐

Relative total transition intensity ☐

Multipolarity of transition ☐

Mixing ratio ☐

Total conversion coefficient ☐

Adding remark ☐

[Final level \(E, J \$\pi\$, T \$_{1/2}\$, etc.\)](#)

Query parameters:

Energy (keV) ☒ Select for output

“Relational ENSDF”:
 query for levels with $J^\pi = 7/2^-$, isospin $T = 3/2$, energies $E = 1 - 13$ MeV and photon energies $E_\gamma = 2 - 5$ MeV (final level energy and J^π are requested).

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ENSDF Source	Nucleus	Level energy	Spin-parity	Half-life	Isospin	Photon energy	Level energy (fin.)	Spin-parity (fin.)
39.26	19-K-39	6546 (2)	7/2-	14 FS	3/2	3732	2814.3 (2)	7/2-
41.47	20-CA-41	7146 (4)	7/2-		3/2	4186	2959.3 (6)	7/2-
51.78	25-MN-51	4451 (2)	7/2-		3/2	2141	2310.0 (5)	5/2(-)
51.78	25-MN-51	4451 (2)	7/2-		3/2	2194	2255.7 (1)	(5/2-)
51.81	25-MN-51	4451 (2)	(7/2)-		3/2	2141	2310.0 (5)	5/2-
51.81	25-MN-51	4451 (2)	(7/2)-		3/2	2194	2255.7 (1)	(5/2-)
57.61	28-NI-57	5238.8 (7)	7/2-		3/2	2008.7	3230.1 (7)	7/2-
57.61	28-NI-57	5238.8 (7)	7/2-		3/2	2661.4	2577.4 (5)	7/2-
59.70	29-CU-59	5897 (4)	7/2(-)		3/2	2782	3114.1 (5)	5/2-
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	2563	3930.0 (24)	5/2+
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	2587	3905.2 (18)	3/2-
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	2606	3885.5 (21)	3/2-
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	2794	3699 (4)	7/2-
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	2919	3573.9 (8)	5/2,7/2
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	2942	3550.6 (13)	5/2-
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3059	3434 (4)	5/2
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3184	3309.0 (20)	7/2(-)
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3378	3114.1 (5)	5/2-
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3451	3042.71 (17)	9/2+
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3565	2928.2 (16)	5/2(-)
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3777	2715.01 (13)	7/2(-)
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3784	2706.04 (22)	5/2(-)
59.70	29-CU-59	6493 (4)	7/2(-)		3/2	3829	2664.50 (17)	(9/2-)
59.74	29-CU-59	5897	7/2-		3/2	2782	3115	5/2-

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[Core information \(Nucleus, Levels, Gamma transition, Decays, Data type\)](#)

[Data type \(any, adopted, experimental\)](#)

[Nucleus \(Z, A\)](#)

Query parameters:

Charge Number (Element) *Be,Zr,Fe-Zn

Mass Number

Stable ☐

[Levels \(E, JPI, T1/2, etc.\)](#)

Query parameters:

Energy (keV) *100-500, *1550,7000-10000

Spin and parity or ☐ Stable

Half-life times

Angular momentum transfer

Spectroscopic strength

Metastable ☐

Isospin

Adding remark

[Gamma transition \(Gamma ray, Final level\)](#)

[Decays \(Parent level, B+/-, EC, Alpha\)](#)

[Additional information \(Experiment, Bibliography, Nucleus parameters\)](#)

[Experiment information \(Decays, Reaction\)](#)

[Bibliography information \(Date, Reference, Publication information\)](#)

Query parameters:

Date *1990, 1995, *1991,1997-2000

Reference

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ENSDF Source	Nucleus	Level energy	Isospin	Date
6.2	1-H-6	0.0	2	200212
6.3	2-HE-6	0.0	1	200212
6.3	2-HE-6	1797 (25)	1	200212
6.3	2-HE-6	13.9E3 (2)	1	200212
6.17	3-LI-6	3562.88 (10)	1	200212
6.17	3-LI-6	5366 (15)	1	200212
6.17	3-LI-6	17985 (25)	1	200212
6.17	3-LI-6	21.5E3	1	200212
6.17	3-LI-6	24779 (54)	1	200212
6.17	3-LI-6	24890 (55)	1	200212
6.17	3-LI-6	26590 (65)	1	200212
6.41	4-BE-6	0.0	1	200212
6.41	4-BE-6	1670 (50)	1	200212
15.4	6-C-15	0.0	3/2	200204
15.12	7-N-15	11615 (4)	3/2	200204
15.12	7-N-15	12522 (8)	3/2	200204
15.12	7-N-15	19500	3/2	200204
15.12	7-N-15	20120 (50)	3/2	200204
15.12	7-N-15	23190 (60)	3/2	200204

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117.50	51-SB-117	12290 (15)	17/2	200205
117.50	51-SB-117	12455 (15)	17/2	200205
117.50	51-SB-117	12587 (15)	17/2	200205
120.40	51-SB-120	10204 (30)	10	200209
120.40	51-SB-120	11354 (30)	10	200209
120.40	51-SB-120	11994 (30)	10	200209
120.40	51-SB-120	12314 (30)	10	200209
120.40	51-SB-120	12504 (30)	10	200209
120.40	51-SB-120	12604 (30)	10	200209
120.40	51-SB-120	12784 (30)	10	200209
120.40	51-SB-120	12914 (30)	10	200209
120.40	51-SB-120	13034 (30)	10	200209
120.40	51-SB-120	13124 (30)	10	200209
143.14	58-CE-143	0.0	27/2	200201
143.14	58-CE-143	808.2 (3)	27/2	200201
143.14	58-CE-143	862.1 (3)	27/2	200201
143.14	58-CE-143	1172.5 (3)	27/2	200201
143.14	58-CE-143	1195 (10)	27/2	200201
143.14	58-CE-143	1298 (5)	27/2	200201
170.14	69-TM-170	15492 (7)	17	200211
170.35	71-LU-170	12855 (20)	15	200211

...

Relational ENSDF query for all nuclear levels included into the ENSDF in 2002 for which information on isospin value is available.

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Anugular momentum transfer any ☐

Spectroscopic strength ☐

Metastable any ☐

Isospin 2 ☒

Adding remark any ☐

[Gamma transition \(Gamma ray, Final level\)](#)
[Gamma ray \(E, Int, Mult, Mix, Convers.\)](#)

Query parameters: Select for outp

Energy of the γ -ray (keV) ☒

Relative photon intensity ☐

Relative total transition intensity ☐

Multipolarity of transition any any ☒

Mixing ratio ☐

Total conversion coefficient ☐

Adding remark any ☐

[Final level \(E, JPI, T1/2, etc.\)](#)

Query parameters: Select for output

Energy (keV) ☒

Spin and parity ☐

Half-life times Y ☐ or ☐ Stable ☐

Anugular momentum transfer any ☐

Spectroscopic strength ☐

Isospin 1 ☒

Metastable state indicator any ☐

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ENSDF Source	Nucleus	Level energy	Isospin	Photon energy	Multipolarity	Level energy (fin.)	Isospin (fin.)
20.17	10-NE-20	18430 (7)	2	6208 (21)	[M1]	12221 (4)	1
24.20	12-MG-24	15436.4 (6)	2	4723.7	M1	10712.2 (2)	1
24.20	12-MG-24	15436.4 (6)	2	5467.9	M1	9967.8 (3)	1
32.23	16-S-32	12049 (1)	2	2840 (1)	M1	9208.1 (7)	1
32.23	16-S-32	12049 (1)	2	3922 (1)	M1	8126.5 (6)	1
32.23	16-S-32	12049 (1)	2	5046 (1)	M1	7002.5 (10)	1
40.67	20-CA-40	11988 (2)	2	1669	M1	10318.8 (4)	1
40.67	20-CA-40	11988 (2)	2	2123	D	9865.15 (11)	1
44.68	22-TI-44	9298 (2)	1+2	2082	M1	7216 (2)	1
44.68	22-TI-44	9338 (2)	1+2	2122	M1	7216 (2)	1

Get all data

Done

Relational ENSDF query for γ -transitions with changing of isospin value from 2 to 1 (photon energy and multipolarity values requested).

Relational ENSDF query for nuclei with levels having isospin value $T \geq 10$.

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CDFE search engine - Mozilla

http://cdfe.sinp.msu.ru/cgi-bin/nessy/current/nessy.cgi

Construct your query and output by sequentially selecting fields. One output field must be selected (not be blank).

Core information (Nucleus, Levels, Gammas)

Data type (any, adopted, experimental)

Nucleus (Z, A)

Query

Charge Number (Element)

Mass Number

Stable

Levels (E, JPI, T1/2, etc.)

Query

Energy (keV)

Spin and parity

Half-life times

Angular momentum transfer

Spectroscopic strength

Metastable

Isospin

Adding remark

any

10-99999

any

ENSDF Source	Nucleus	Level energy	Spin-parity	Isospin
117.18	49-IN-117	14945 (6)	(1/2+)	21/2
117.18	49-IN-117	15075 (6)	(3/2+)	21/2
117.18	49-IN-117	15380 (6)	(1/2+)	21/2
117.18	49-IN-117	15605 (6)	(3/2+)	21/2
120.40	51-SB-120	10204 (30)		
120.40	51-SB-120	11354 (30)		10
120.40	51-SB-120	11994 (30)		10
120.40	51-SB-120	12314 (30)		10
120.40	51-SB-120	12504 (30)		10
120.40	51-SB-120	12604 (30)		10
120.40	51-SB-120	12784 (30)		10
120.40	51-SB-120	12914 (30)		10
120.40	51-SB-120	13034 (30)		10
120.40	51-SB-120	13124 (30)		10
121.13	50-SN-121	15005 (50)	9/2+	23/2
121.13	50-SN-121	16304 (50)	1/2-	23/2
121.13	50-SN-121	16610 (50)	3/2-	23/2
123.12	50-SN-123	16943 (50)	(9/2+)	25/2
123.12	50-SN-123	17306 (50)	(1/2-)	25/2
123.12	50-SN-123	17656 (50)	(3/2-)	25/2
128.30	57-LA-128	11944 (22)	(0+)	12
135.42	57-LA-135	12815	(3/2+)	23/2

CDFE search engine - Mozilla

http://cdfe.sinp.msu.ru/cgi-bin/nessy/current/nessy.cgi

128.30	57-LA-128	11944 (22)	(0+)	12
135.42	57-LA-135	12815	(3/2+)	23/2
135.42	57-LA-135	13053	(1/2+)	23/2
135.42	57-LA-135	14222	(7/2-)	23/2
135.42	57-LA-135	14360	(3/2-)	23/2
135.42	57-LA-135	14767	(1/2-)	23/2
135.42	57-LA-135	14936		23/2
135.42	57-LA-135	15514	(1/2-, 3/2-)	23/2
135.42	57-LA-135	15773		23/2
143.14	58-CE-143	0.0	3/2-	27/2
143.14	58-CE-143	808.2 (3)	3/2-	27/2
143.14	58-CE-143	862.1 (3)	(1/2-)	27/2
143.14	58-CE-143	1172.5 (3)	3/2-, (1/2-)	27/2
143.14	58-CE-143	1195 (10)	(5/2-)	27/2
143.14	58-CE-143	1298 (5)	(5/2-)	27/2
149.46	63-EU-149	14287	(7/2-)	25/2
149.46	63-EU-149	14635	(3/2-)	25/2
149.46	63-EU-149	14804	(3/2-)	25/2
149.46	63-EU-149	15002	(1/2-, 3/2-)	25/2
149.46	63-EU-149	15449	(5/2-)	25/2
170.14	69-TM-170	15492 (7)	0+	17
170.35	71-LU-170	12855 (20)	0+	15
192.42	79-AU-192	14124 (16)	0+	35/2
207.15	82-PB-207	19300 (40)	1/2+	45/2
207.15	82-PB-207	19660 (30)	3/2+	45/2
207.15	82-PB-207	20640 (30)	11/2-	45/2
207.15	82-PB-207	21000 (30)	5/2+	45/2
207.15	82-PB-207	22890 (80)		45/2
208.59	83-BI-208	15165 (6)	(0+)	22
209.67	84-PO-209	16324 (13)	(9/2-)	43/2
209.75	85-AT-209	35E+3 (1)	(9/2-)	43/2

Get all data

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[Levels \(E, JPI, T1/2, etc.\)](#)

Query parameters:

Energy (keV)

Spin and parity

Half-life times

Angular momentum transfer

Spectroscopic strength

Metastable

Isospin

Adding remark

[Gamma transition \(Gamma ray, Final level\)](#)

[Decays \(Parent level, B+/-, EC, Alpha\)](#)

[Additional information \(Experiment, Bibliography, Nucleus parameters\)](#)

[Experiment information \(Decays, Reaction\)](#)

[Bibliography information \(Date, Reference, Publication information\)](#)

[Energy parameters of nucleus \(B-, Alpha energy, N, P separation energy\)](#)

Query parameters:

Total energy available for β^- decay (keV)

Neutron separation energy (keV)

Proton separation energy (keV)

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ENSDF Source	Nucleus	Level energy	Spin-parity	Isospin	Neutron separation energy
13.4	3-LI-9	5380 (60)			4063.6 (20)
9.4	3-LI-9	6430 (15)	GE 9/2		4063.6 (20)
13.4	5-B-13	5024 (6)			4878.0 (18)
13.4	5-B-13	5106 (10)			4878.0 (18)
13.4	5-B-13	5388 (6)			4878.0 (18)
13.4	5-B-13	5550 (7)			4878.0 (18)
13.4	5-B-13	6167 (6)			4878.0 (18)
13.4	5-B-13	6425 (7)			4878.0 (18)
13.4	5-B-13	6934 (9)			4878.0 (18)
13.4	5-B-13	7516 (8)			4878.0 (18)
13.4	5-B-13	7859 (20)			4878.0 (18)
13.4	5-B-13	8133 (7)			4878.0 (18)
13.4	5-B-13	8683 (7)			4878.0 (18)
13.4	5-B-13	9440 (30)			4878.0 (18)
13.4	5-B-13	9500			4878.0 (18)
13.4	5-B-13	10220 (20)			4878.0 (18)
13.4	5-B-13	10890 (20)			4878.0 (18)
13.4	5-B-13	11800			4878.0 (18)
13.11	6-C-13	6800 (2)	5/2+		4946.313 (2)
13.11	6-C-13	7492 (10)	3/2+		4946.313 (2)
13.11	6-C-13	7547 (3)	5/2-		4946.313 (2)
13.11	6-C-13	7686 (6)	3/2+		4946.313 (2)
13.11	6-C-13	820E+1 (10)	3/2+		4946.313 (2)
13.11	6-C-13	8860 (20)	1/2-		4946.313 (2)
13.11	6-C-13	9499.8 (1)	9/2+		4946.313 (2)

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17.12	8-O-17	23500			4143.33 (21)
17.12	8-O-17	24400			4143.33 (21)
25.5	10-NE-25	6280 (50)			4180 (50)
37.7	16-S-37	5054 (2)	9/2+, (7/2+)		4303.58 (9)
37.7	16-S-37	5090 (2)	9/2+, (7/2+)		4303.58 (9)
37.7	16-S-37	5122 (2)	9/2+, (7/2+)		4303.58 (9)
37.7	16-S-37	5505 (2)	5/2-		4303.58 (9)
37.7	16-S-37	5666 (2)	5/2-		4303.58 (9)
37.7	16-S-37	5720 (2)	5/2-		4303.58 (9)
51.6	20-CA-51	5190	(1/2, 3/2, 5/2)		4386 (91)
51.6	20-CA-51	5520	(1/2+, 3/2+, 5/2+)		4386 (91)
51.6	20-CA-51	5910 (40)			4386 (91)
51.6	20-CA-51	6040	(1/2+, 3/2+, 5/2+)		4386 (91)
51.6	20-CA-51	6650	(1/2+, 3/2+, 5/2+)		4386 (91)
51.6	20-CA-51	6820	(1/2+, 3/2+, 5/2+)		4386 (91)
51.6	20-CA-51	7450	(1/2+, 3/2+, 5/2+)		4386 (91)
51.6	20-CA-51	7910	(1/2+, 3/2+, 5/2+)		4386 (91)
52.5	20-CA-52	5570			4.69E3 (47)
52.5	20-CA-52	5800			4.69E3 (47)
52.5	20-CA-52	7010			4.69E3 (47)
52.5	20-CA-52	8210			4.69E3 (47)
52.5	20-CA-52	9190			4.69E3 (47)
136.7	52-TE-136	5160 (3)	(16, 17-)		4.67E+3 (10)
137.9	54-XE-137	5025.1 (16)			4025.5 (3)
137.9	54-XE-137	5080.2 (13)	(+)		4025.5 (3)
137.9	54-XE-137	5125 (3)			4025.5 (3)
137.9	54-XE-137	5132.2 (20)			4025.5 (3)
137.9	54-XE-137	5148.8 (12)			4025.5 (3)
137.9	54-XE-137	5158.2 (16)	(+)		4025.5 (3)
137.9	54-XE-137	5170.2 (8)			4025.5 (3)

Relational ENSDF query for levels with energy more than neutron separation energy (requested also) in region 4 – 5 MeV.

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Nucleus (Z, A)

Query parameters:

Charge Number (Element) 5,20,4-36, "Be,Zr,Fe-Zn" ☒

Mass Number

Stable any ☐

[Levels \(E, JPI, T1/2, etc.\)](#)

[Gamma transition \(Gamma ray, Final level\)](#)

[Decays \(Parent level, B+/-, EC, Alpha\)](#)

[Additional information \(Experiment, Bibliography, Nucleus parameters\)](#)

[Experiment information \(Decays, Reaction\)](#)

Decays

any

target charge

mass

incident

any

A alphas

D deuterons

E electrons

E+ electrons, positive

E- electrons, negative

G gammas

HI

K-

MU-

N neutrons

NN

P protons

PI pions, neutral

PI+ pions, positive

PI- pions, negative

T tritons

Reaction

particle ☒

charge

mass 40

CDFE search engine. - Mozilla

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ENSDF Source	Nucleus	Experiment information
41.19	18-AR-41	40AR(D,PG),2H(40AR,PG)
41.24	19-K-41	2H(40AR,NG)
41.61	20-CA-41	40CA(D,PG),2H(40CA,PG)
46.50	22-TI-46	12C(40CA,A2PG)
47.31	22-TI-47	10B(40CA,3PG), 36S(14C,3NG), 44CA(7LI,3NPG), 31P(19F,N2PG)
47.50	23-V-47	10B(40CA,N2PG),24MG(32S,2APG), 31P(19F,P2NG),40CA(10B,N2PG), 40CA(12C,PAG)
47.60	24-CR-47	10B(40CA,P2NG), 40CA(12C,NAG), 46TI(3HE,2NG)
48.78	24-CR-48	10B(40CA,PNG), 12C(40CA,2N2PG)
48.79	24-CR-48	12C(40CA,2N2PG), 10B(40CA,PNG)
48.86	25-MN-48	12C(40CA,3NP) E=456 MEV
49.45	23-V-49	12C(40CA,3PG), 24MG(32S,3PAG), 27AL(28SI,APNG), 40CA(12C,3PG)
49.58	24-CR-49	12C(40CA,N2PG),40CA(12C,N2PG), (14N,APG),27AL(28SI,APNG)
49.65	25-MN-49	12C(40CA,2NPG) E=160 MEV
49.68	26-FE-49	9BE(58NI,X), 40CA(12C,3N), W(40CA,X)
60.69	28-NI-60	60NI(40AR,40AR)
73.55	35-BR-73	40CA(40CA,A3PG)
73.59	36-KR-73	40CA(36AR,2PNG),(40CA,A2PNG)
75.61	37-RB-75	40CA(40CA,APG)
77.62	37-RB-77	40CA(40CA,3PG)
77.64	38-SR-77	40CA(40CA,2PNG)

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CDFE search engine. - Mozilla

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95.68	46-PD-95	58NI(40CA,N2P)
95.69	47-AG-95	58NI(40CA,P2N)
96.70	45-RH-96	64ZN(40CA,A3PNG)
96.74	46-PD-96	60NI(40CA,2P2NG)
97.75	46-PD-97	64ZN(40CA,A2PNG)
99.73	47-AG-99	64ZN(40CA,3P2NG)
126.55	58-CE-126	92MO(40CA,2PAG)
126.57	59-PR-126	92MO(40CA,APNG)
128.59	59-PR-128	94MO(40CA,APNG)
128.61	60-ND-128	92MO(40CA,2P2NG)
130.75	59-PR-130	94MO(40CA,3PNG)
130.82	60-ND-130	92MO(40CA,2PG),96RU(40CA,2PAG)
130.83	60-ND-130	94MO(40CA,2P2NG)
131.57	60-ND-131	94MO(40CA,2PNG)
132.59	62-SM-132	96RU(40CA,2P2NG)
133.56	61-PM-133	96RU(40CA,3PG) E=180 MEV
133.59	62-SM-133	96RU(40CA,2NPG)
133.60	62-SM-133	96RU(40CA,2PNG)
144.68	64-GD-144	108PD(40AR,4NG)
145.67	64-GD-145	110PD(40AR,5NG)
150.63	66-DY-150	114CD(40AR,4NG)
161.50	72-HF-161	126TE(40CA,5NG)
162.55	72-HF-162	126TE(40CA,4NG), 116SN(48TI,2NG)
180.48	78-PT-180	144ND(40AR,4NG)
181.41	78-PT-181	144ND(40AR,3NG)
181.50	80-HG-181	144SM(40AR,3NG)
192.64	82-PB-192	182W(16O,6NG), GD(40AR,XNG)
206.70	88-RA-206	170YB(40AR,4NG)

Get all data

Relational ENSDF query for all reactions with incident A = 40 nuclides.

The screenshot shows the ENSDF database interface. The browser address bar displays the URL: http://cds.cern.ch/record/1089999/files/ensdf-current/ensdf.cgi. The page contains a table with columns: ENSDF Source, Nucleus, Level energy, Spin parity, Photon energy, Level energy (fin), and Spin parity (fin). Two arrows are drawn over the table: a red arrow pointing from the 'Level energy' column to the 'Spin parity' column, and a blue arrow pointing from the 'Spin parity' column to the 'Photon energy' column.

ENSDF Source	Nucleus	Level energy	Spin parity	Photon energy	Level energy (fin)	Spin parity (fin)
86.61	40-ZR-86	10918	(20+)	776	10142.9 (11)	(20+)
86.66	40-ZR-86	10918	20+	776	10142	20+
116.83	54-XE-116	7467.0 (5)	(20+)	319.2 (3)	7147.8 (5)	(20+)
116.86	54-XE-116	7467.0 (5)	(20+)	319.2 (3)	7147.8 (5)	(20+)
168.35	70-YB-168	4786	(20+)	450	4336.9 (8)	(20+)
168.44	70-YB-168	4786	(20+)	450	4336.9 (8)	20+
182.35	76-OS-182	5378.1 (5)	(20+)	334.0 (5)	5024.5 (5)	20+
182.35	76-OS-182	5378.1 (5)	(20+)	635.5 (5)	5142.4 (5)	(20+)
182.40	76-OS-182	5357.8 (6)	20(+)	334.0 (5)	5023.9 (6)	20+
182.40	76-OS-182	5777.6 (6)	20(+)	635.5 (5)	5142.1 (7)	20+
182.44	78-PT-182	4918.9 (7)	(20+)	191 (1)	4728.5 (5)	(20+)
182.44	78-PT-182	4918.9 (7)	(20+)	191 (1)	4728.5 (5)	(20+)
184.52	78-FT-184	4815.4	20(+)	322.7	4493.5	20+
192.47	80-HG-192	5587.1 (8)	(20+)	270	5316.5 (6)	(20+)
192.49	80-HG-192	5587	(20+)	270	5316.5 (6)	20+
212.25	86-RN-212	6167.4 (6)	(20+)	741.9	5427.2 (5)	(20+)
212.28	86-RN-212	6167.3	(20+)	741.9 (2)	5427.1	(20+)
238.6	92-U-238	3502	(20+)	882	2619.1 (8)	20+
238.6	92-U-238	3773	(20+)	1154	2619.1 (8)	20+
238.15	92-U-238	3502	(20+)	882	2619.0 (8)	20+
238.15	92-U-238	3773	(20+)	1154	2619.0 (8)	20+

Relational ENSDF query for γ -transitions between the levels with definite J^π values (in case both -20^+).

The screenshot shows a web browser window titled "CDFE search engine - Mozilla". The address bar displays "http://cdfe.sinp.msu.ru/cgi-bin/nessy/current/nessy.cgi". The browser's menu bar includes File, Edit, View, Go, Bookmarks, Tools, Window, and Help. The toolbar contains buttons for Back, Forward, Reload, Stop, Search, and Print. The status bar at the bottom shows "Done".

The main content area displays a table with the following data:

ENSDF Source	Nucleus	Level energy	Spin-parity	Photon energy	Level energy (fin.)	Spin-parity (fin.)
194.34	80-HG-194	6789.7 (6)	(20+)	757.8 (2)	6031.9 (5)	(22+)
194.37	80-HG-194	6789.5 (6)	(20+)	757.8 (2)	6031.6 (6)	(22+)

A green arrow points to the "Spin-parity (fin.)" column in the second row of the table.

The only one level with $J^\pi_{\text{final}} = 22^+$.

CDFE => Online Services => Relational ENSDF - Microsoft Internet Explorer

Адрес: <http://cdfe.sinp.msu.ru/services/ensdfr/en.html>

CDFE => Online Services => Relational ENSDF

EVALUATED NUCLEAR STRUCTURE DATA FILE (ENSDF) Complete Nuclear Spectroscopy Database "Relational ENSDF"

Construct your query and output by sequential openings of needed fields.
One output field must be selected (not be blank) at least. [\[Help \]](#)

[Core information \(Nucleus, Levels, Gamma transition, Decays, Data type\)](#)
[Data type \(any, adopted, experimental\)](#)
[Nucleus \(Z, A\)](#)
[Levels \(E, JPI, T1/2, etc.\)](#)

	Query parameters:	Select for output
Energy (keV)	"100-500", "1550,7000-10000"	<input type="checkbox"/>
Spin and parity		<input type="checkbox"/>
Half-life	<input type="text"/> Y or <input type="checkbox"/> Stable	<input type="checkbox"/>
Angular momentum transfer	<input type="text"/> any	<input type="checkbox"/>
Spectroscopic strength	<input type="text"/>	<input type="checkbox"/>
Metastable state label	<input type="text"/> any	<input type="checkbox"/>
Isospin	<input type="text"/>	<input type="checkbox"/>
Parent decay on the level (under construction)	<input type="text"/> any	<input type="checkbox"/>
Electric moments (under construction)	<input type="text"/> any	<input type="checkbox"/>
Magnetic moments (under construction)	<input type="text"/> any	<input type="checkbox"/>
Nuclear deformation parameter (under construction)	<input type="text"/> any	<input type="checkbox"/>
Level width (under construction)	<input type="text"/> any	<input type="checkbox"/>
Reduced electric transition probability (upward) for the transition from the ground state to this level (under construction)	<input type="text"/> any	<input type="checkbox"/>
Nuclear configuration of the level (under construction)		<input type="checkbox"/>
g-factor of the level (under construction)		<input type="checkbox"/>
Ionization State (under construction)		<input type="checkbox"/>
Additional remark	<input type="text"/> any	<input type="checkbox"/>

Готово Интернет

**Relational ENSDF Levels data search perspectives
(new fields - under construction).**